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## Food Composition in Striped Field Mice Living at Localities of Various Degrees of Urban Development

POKARM MYSZY POLNEJ Z OBSZARÓW O RÓŻNYM STOPNIU URBANIZACJI

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The diet of *Apodemus agrarius* (Pallas, 1771) collected within three different localities was studied by means of stomach contents analysis. The rodents living in two of the localities (a suburban wood, and a remote area of city park) had the diet typical for the species, with seeds making up the bulk of diet (54—66%). The animals collected in the part of park closest to the city centre fed mainly on green food (71% of the diet). Hence the process of taking over urban and polluted areas by *A. agrarius* could be explained by the ability of the species to modify its food habits.

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Striped field mouse *Apodemus agrarius* (Pallas, 1771) is a rodent species that has started getting to the urban green areas (Andrzejewski *et al.*, 1978). The urban populations of the species differ in many aspects of their demography from those living in natural ecosystems (Andrzejewski *et al.*, 1978; Babińska-Werka, 1981; Babińska-Werka & Grabarczyk, 1981). Also the feeding habits of mice living under urban conditions differ much from those inhabiting suburban situations (Babińska-Werka, 1981; Babińska-Werka & Grabarczyk, 1981).

The aim of this study was to determine the composition of diet in striped field mice inhabiting areas of various degrees of urbanization.

### 1. STUDY AREA

The animals were collected in three forested areas situated at various distances from Białystok city centre. Two areas (Zwierzyniec I and Zwierzyniec II) are parts of a city park. Zwierzyniec I is a portion of once moist forest now drained, covered with multispecies forest stand including *Carpinus betulus* L., *Acer* sp. *Tilia cordata* Mill., *Betula* sp., and *Picea excelsa* (Lam.) Lk. The undergrowth

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includes shrubs *Corylus avellana* L., *Evonymus europaea* L., *Rubus* sp., and tree saplings. The lowest layer consists of abundant herbaceous vegetation. Zwierzyniec II area belongs to the *Carex elongata-Alnus glutinosa* type of plant community, and is situated in about 1 km distance from the other plot. The forest stand and herbaceous layer are formed by similar species as those in the Zwierzyniec I plot. The herbaceous layer is very rich and in spring it covers completely the area. The plot was situated between two streets carrying heavy traffic, and was frequented by town inhabitants who normally rest here or use it for recreation activities. The annual dust fallout on these two areas is about 50 tonnes/km$^2$, and $SO_2$ concentration in air — 0.0245 mg/cm$^3$.

The third plot was set in a forest at Fasty in the north-western part of town, close to a cotton textile factory. It is well removed from road traffic but close to a heavily polluted Biała River. The vegetation belings to a moist forest type which is drying up after a drainage project has been implemented in the area. The forest stands is dominated by black alder *Alnus glutinosa* (L.) Gaertn., while the undergrowth, by rowan *Sorbus aucuparia* L., and raspberry *Rubus* sp. In the herbaceous layer there is a distinctly mosaic distribution of plant species. In moist places some marsh species can be found, such as *Solanum dulcamara* L., *Iris pseudacorus* L., *Lycopus* sp., and numerous species of genus *Carex* and family *Felicinae*. The drier portions are overgrown with *Oxalis acetosella* L., *Majanthemum bifolium* (L.) P. W. Schm., *Urtica dioica* L., *Geum urbanum* L. and others. This area is also heavily polluted: the annual dust fallout is about 75-100 tonnes/km$^2$, while the $SO_2$ concentration in air (0.035 mg/cm$^3$) exceeds three times that of Zwierzyniec Park.

## 2. MATERIAL AND METHODS

*Apodemus agrarius* were collected during summer (July) and autumn (October) 1979 by using snap-traps. The bait was prepared from flour fried in cooking oil. The traps, spaced in about 20 m distances, were set in a single line. In all, 57 individuals were caught.

The animals collected were then taken to laboratory, weighed, their sex and reproductive status determined and the bodies dissected. The stomachs were removed and put into 4% formaldehyde solution for fixation. Prior to making preparations the stomachs were rinsed in water. The stomach contents were then put on a watch-glass with few drops of water and a drop of Gramm II reagent in order to stain starch. After careful mixing, four microscopic slides were prepared from each stomach. To assess the components qualitatively a 100-square grid was used for microscopic observations. Each slide was assessed by scanning ten not overlapping fields. The data from observations were cumulated, and average percentages calculated.

The plant material was identified by comparing it with permanent histological preparations, drawings of epidermal cells from stems and leaves and test preparations. Such preparations were obtained from stomachs of *A. agrarius* that were fed in the laboratory exclusively on one plant species to fill the alimentary tract completely (Kostelecka-Myrcha & Myrcha, 1964; Holišova, 1967; Gębczyńska, 1976; Babińska-Werka, 1981). The seeds were distinguished from other food components on the basis of their characteristic shape, and the colour and ornamentation of shells. The animal material was identified by remnants of chitin, fragments of legs, scales from butterfly wings and single whole specimens (Babińska-Werka & Grabarczyk, 1981).

## 3. RESULTS

### 3.1. Zwierzyniec Park I

17 stomachs of mice (10♀♀+7♂♂) obtained from this study area in summer contained both plant and animal food. The plant food included 17 species of plants belonging to herbaceous layer. Among those found most frequently were: *Geum urbanum* L. (82.5% of stomachs), *Anemone nemorosa* L., *Oxalis acetosella* L. and *Aegopodium podagraria* L. (each in 58.8% of stomachs) (Table 1). Tree and herb seeds were found in 88.2%, roots in 11.8%, and tree bark in a mere 5.9% of stomachs (Table 1). Invertebrates were found in 88.2% of stomachs. In more than half of stomachs analyzed, larval forms of a nematode of genus *Heligmosomum*

Table 1

Percentages of stomachs of *A. agrarius* containing various food items.

| Item | Summer | | | Autumn |
|---|---|---|---|---|
| | Zwierzyniec I | Zwierzyniec II | Fasty | Fasty |
| *Aegopodium podagraria* L. | 58.8 | 11.0 | 33.0 | 30.0 |
| *Anemone nemorosa* L. | 58.8 | 67.0 | 66.0 | — |
| *Asarum europaeum* L. | 5.9 | — | — | — |
| *Carex* sp. | 5.9 | — | 11.0 | — |
| *Chrysosplenium alternifolium* L. | 5.9 | — | 11.0 | 15.0 |
| *Galeobdolon luteum* Huds. | — | 11.0 | — | — |
| *Geum urbanum* L. | 82.5 | 67.0 | 55.0 | 92.0 |
| *Hepatica nobilis* Garsault | — | 22.0 | — | — |
| *Lathyrus vernus* Bernh. | — | 28.0 | — | — |
| *Lysimachia nummularia* L. | 5.9 | — | 22.0 | — |
| *Majanthemum bifolium* Schm. | 5.9 | 22.0 | 33.0 | 15.0 |
| *Mycelis muralis* (L.) | 5.9 | — | — | — |
| *Nepeta cataria* L. | — | — | — | 8.0 |
| *Oxalis acetosella* L. | 58.8 | — | 66.0 | 54.0 |
| *Ranunculus repens* L. | — | 6.0 | — | 15.0 |
| *Ribes rubrum* L. | — | 6.0 | — | — |
| *Stachys silvatica* L. | — | 17.0 | 44.0 | 15.0 |
| *Stellaria holostea* L. | 5.9 | — | — | — |
| *Stellaria nemorum* L. | 17.6 | 6.0 | — | — |
| *Taraxacum officinale* Web. | 5.9 | — | — | — |
| *Urtica dioica* L. | — | — | 33.0 | 15.0 |
| seeds | 88.2 | 100.0 | 100.0 | 69.0 |
| fruits | 11.8 | — | — | — |
| *Fragaria vesca* L. fruits | — | 6.0 | — | — |
| *Rubus idaeus* L. fruits | — | 28.0 | — | — |
| green tissue | — | 56.0 | 55.0 | 8.0 |
| stem epidermis | — | 11.0 | 22.0 | — |
| bark | 5.9 | — | — | 8.0 |
| roots | 11.8 | 6.0 | 44.0 | 8.0 |
| animal food | 76.5 | 39.0 | 33.0 | 8.0 |
| parasites | — | 50.0 | 33.0 | 38.0 |
| sand | 11.8 | — | — | — |

occurred, whose adult forms are parasites of the small intestine of mice (Kisielewska, pers. comm.).

The main component of summer diet of the striped field mice were nevertheless the green parts of plants that made 70.8% of the entire diet. The most preferred species was *Geum urbanum*, that made 23.9 of total food and 33.7% of green parts. *Anemone nemorosa* and *Oxalis acetosella* contributed much less to the overall diet: 7.8 and 5.3% respectively. The fractions made by all the remaining species ranged from 1.3 to 0.1%. Seeds and fruits together constituted 19.4% of food with fruits claiming only 0.4% (Fig. 1). In the animal food that made 9.1% of the entire diet, insects and earthworms dominated — providing 70.4 and 28.0% of the animal food respectively.

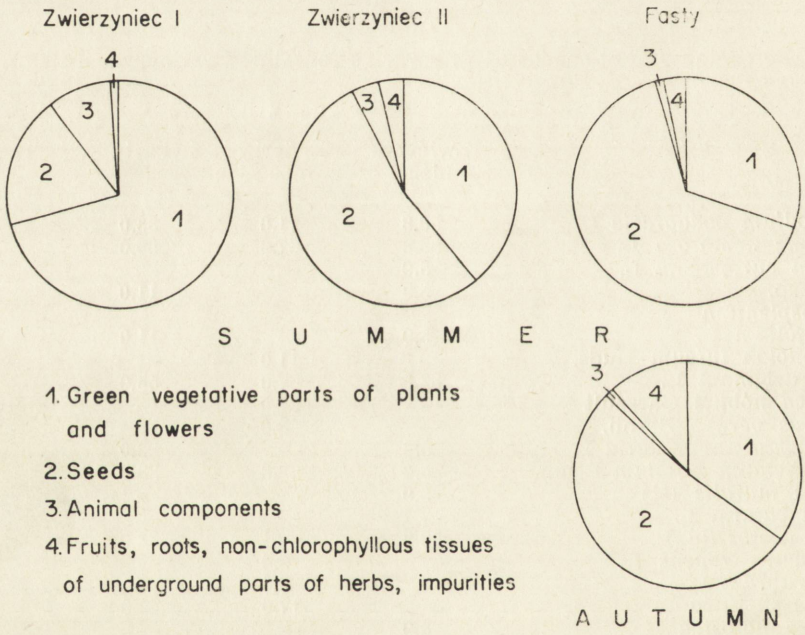


**Fig. 1. Relative proportions of various components in the food of *A. agrarius*.**

### 3.2. Zwierzyniec Park II

All 18 mice (11♀♀+7♂♂) were caught in summer. The mice fed mainly on seeds that were found in all stomachs where they constituted 53.7% of the diet. Apart from seeds, the following species were frequently found: *Oxalis acetosella* (72.0% of stomachs), *Anemone nemorosa* and *Geum urbanum* (in 67.0% of stomachs each), *Lathyrus vernus* (28.0%), *Hepatica* nobilis and *Majanthemum bifolium* (in 22.0% of stomachs each). The plant food made up 39.3% of the volume of food. The remaining

7.0% of diet were made by green parts of plants (0.04%), fruits (1.7%), and invertebrates (3.8%) (Table 1, Fig. 1). Half of the animals collected in this area were found to host internal parasites of genus *Heligmosomum* (Kisielewska, pers. comm.).

### 3.3. Fasty Wood

In this area the animals were collected in both summer (9 individuals, 2♀♀+7♂♂) and autumn (13 individuals, 5♀♀+8♂♂). Among 13 species of herbs found, the most frequent were: *Anemone nemorosa, O. acetosella* (in 66.0% of stomachs each), *Geum urbanum* (55.0%), *Stachys sylvatica* (44.0%), and *A. podagraria* and *Urtica dioica* (in 33.0% each) (Table 1).

In this area the main components of diet were seeds (66.4% of the diet) while the green parts of herbs constituted 29.7% and the animal food — 1.1% (Fig. 1).

In autumn, the diet of *A. agrarius* was found to include 9 species of herbs with *G. urbanum, O. acetosella,* and *A. podagraria* occurring most frequently (in 92.0, 54.0, and 30.0% of stomachs respectively) (Table 1). Seeds were found in 69.0% of stomachs and provided more than half of the volume of food. The remaining fractions of diet were made up by fragments of herbs (33.2%), tree bark (10.1%), with roots, animal food and parasites to complete the picture (Fig. 1).

## 4. DISCUSSION

Previous studies on the composition of food in *A. agrarius* have indicated that its diet is dominated by seeds (up to 90% in terms of frequency and 50 to 90% of volume). This component dominates not only in the diets of animals living in natural habitats (Holišova, 1967; Babińska-Werka, 1981), but also constitutes most of the diet of animals living within green areas of towns (Babińska-Werka, 1981). The animal food, although found in 60.7% of stomachs, constitutes only 10% of their volume. The green parts of plants are a supplementary source of energy with herbs dominating in natural habitats (Holišova, 1967) and grasses dominating in central parks in Warsaw (Babińska-Werka, 1981). In urban areas of Białystok *A. agrarius* feed mainly on herbs. The most striking difference however appeared in one of the study areas (Zwierzyniec I) where it was the green parts that formed the bulk of diet (71%) and not seeds and fruits that were found to constitute only 19.4% of the diet. In the remaining two areas (Zwierzyniec II and Fasty Wood) the seeds dominate.

Such dramatic change in food habits seemed difficult to comprehend until later studies on the diet of *A. agrarius* living in a heavily polluted

environment have been completed (Gębczyńska & Morzuch, in prep.) showing how profoundly can this species change its food habits. On large number of samples it was shown that in forest of an industrial region of Silesia where more than half of diet of mice living there was made up by green parts of plants. In spring, this component constituted merely a few per cent while in autumn its fraction rose to a quarter of the whole diet.

The Zwierzyniec II site where the diet differs remarkably from that found in Zwierzyniec I site has a similar value of pollution fallout. It may nevertheless be supposed that these two sites, although situated near each other, differ remarkably in respect to the number of seeds produced. Such cause of change in food preferences was identified in studies in the Silesian forests (Gębczyńska & Morzuch, in prep.). A deteriorating food supply did not brought about any decrease in numbers of *A. agrarius* but rather a shift from the diet typical for mice (more seeds) to the one typical for voles (more green food). Changes in the environment associated with urbanization generally depress the numbers of small mammals but *A. agrarius* remains (Andrzejewski *et al.*, 1978). In populations of *A. agrarius* living in such conditions the natality index drops while the survival of adults rises (Babińska-Werka *et al.*, 1981). Heavy pollution of the environment may account for the fact that such polluted areas are inhabited by only four species including *A. agrarius* whose numbers are higher than in natural habitats (Walkowa *et al.*, 1982). All this supports the earlier hypothesis (Andrzejewski *et al.*, 1982) saying that the striped field mouse can restructure not only its demographic parameters but the physiological ones as well, as indicated by its ability to shift from one kind of food to another.

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